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Jacquelyn A. Shaw

TROUBLED WATERS UNDER THE BRIDGE: RED TIDE, AQUATIC POLLUTION, AND THE PRINCE EDWARD ISLAND SHELLFISH POISONING OF 1987

JACQUELYN A. SHAW[†]

ABSTRACT

Toxic red tides, such as the one that poisoned PEI in 1987, are a coastal aquatic phenomenon that cause harm to wildlife and humans alike, seemingly with increasing frequency. They appear tied to nutrient pollution of aquatic habitats, especially by the food-producing industries, such as aquaculture and industrial farming. Canada has made (non-binding) global commitments to protect marine waters from such land-based pollution, resulting in its 'National Program of Action'. To date, however, Canada's attempts to meet this goal have been hampered by the federal division of powers, and by an overall fragmented legal protection for the aquatic environment. Respecting no legal boundaries, aquatic habitats are practically a metaphor for environmental interconnectedness, yet Canada's legal framework ignores this holistic picture. The current legislation perpetuates the historical view of food production as environmentally benign and of food security as having higher priority than environmental integrity. Ultimately though, a healthy, safe food supply depends entirely upon a healthy environment. Red tides are thus a dangerous reminder that Canada must urgently begin to deal with the interconnectedness of its lands, waters and human activities in future legal protections for aquatic habitats.

[†] The author is a third-year student in Dalhousie University's Bachelor of Laws program, and has interests in the fields of both environmental and health law, reflecting her previous Master of Science and Honours Bachelor of Science degrees in the life sciences. Past studies in marine ecology at the Bermuda Biological Station for Research helped to inspire the writing of this paper.

I. Land, Water and the Law: A Troubled Relationship

In Prince Edward Island ('PEI'), Canada's smallest province, tranquil beauty and scenic vistas belie a troubled relationship to the land. Few would have predicted that this idyllic setting, far from urban sprawl or obvious industrial presence, might be the scene of environmental retribution. Yet, in the fall of 1987, PEI – then deemed a "red tide free zone" – suffered a severe red tide by an organism previously thought harmless, the marine algae *Nitzchia pungens f. multiseries*, which revealed an illness new to science: Amnesic Shellfish Poisoning (ASP). In killing four and sickening 107, it left a lasting memento of our complex, neglected relationship to our ocean environment.[1] ASP's destructive impact revealed much about Canada's fragmented approach to legal protection of its fresh and marine waters and to the regulation of human activities that may place aquatic environments at risk. In Canada, as in many industrialized nations, food production industries (farming and aquaculture) have traditionally been viewed as environmentally benign or a less urgent concern than environmental security, despite the irony that the integrity of our food supply relies on a healthy environment. There is an urgent need for Canadian law to begin to reflect the interconnected nature of aquatic ecosystems and their inseparable relationship to the lands they adjoin.

II. The Global Red Tide Phenomenon and The Impact of Water Pollution

Part of the mechanism underlying red tides is the natural seasonal "bloom", a surge in reproduction of microscopic algae prompted by nutrient up-welling from the seasonal mixing of stratified seawater layers. A red tide may be created from this natural bloom when the suspended, single-celled algae become concentrated resulting in a bloom intense enough to cause a reddish discoloration of the water.[2] So dense are these

[1] J.Y. Couture *et al*., "Spatial and Temporal Variation of Domoic Acid in Molluscs of *pseudo-nitzschia* spp. Blooms in the St Lawrence from 1998 to 2000" (2001) 2375 Canadian Technical Report of Fisheries and Aquatic Sciences 1.

[2] J. Martin, *Underwater World: Red Tides* (St Andrews, Canada: Fisheries and Oceans, 1990) at 7; C. Mlot, "The Rise in Toxic Tides," online: Science News Online <http://www.sciencenews.org/su_arc97/9_27_97/ bob1.htm>.

algal blooms that they may even be visualized from space via satellite imagery.[3] While not all red tides are harmful to humans or aquatic life, they are notorious largely because of their ability to produce toxins. The toxins produced by red tide algae are of great concern because of their potency, their impacts on fisheries and the illnesses they produce in humans. The associated economic impacts are in the millions of dollars.[4] The newest disease caused by such toxins, Amnesic Shellfish Poisoning, was discovered in PEI in the red tide of 1987.[5]

The occurrence of red tides appears to be at least secondarily affected, or exacerbated, by human activities. There is proof that red tide algae can be transported over vast intercontinental distances in the waters in ships' ballast, mirroring globalization and international trade patterns.[6] Anthropogenic environmental impacts may also help create the environmental conditions that trigger or sustain red tides. Of concern is the fact that many researchers report a steady global increase in red tide events over the past two to three decades.[7] The reasons for the apparent increase are complex and multifactorial.[8] One of the most frequently suggested factors involved in promoting red tide is water pollution in the form of sediments, chemicals, and excess nutrients, particularly nitrogen and phosphorus, from a variety of sources.

Red tide species respond strongly to nutrient levels. To some extent, but perhaps only within certain bounds, the nutrient effect may be reversible. In Japan's Seto Inland Sea, introducing pollution controls halved the frequency of red tide events within four years.[9] Human aquatic inputs may encourage red tides by enriching nutrient levels, including phosphorous and nitrogen, which are of primary concern. Potential sources of this type of water pollution include land-based agri-

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[3] "Satellite imagery during bloom events," online: The Harmful Algae Page <http://www.redtide.whoi.edu/ hab/rtphotos/rtphotos.html>.

[4] Martin, *supra* note 2 at 3, 4.

[5] Martin, *supra* note 2 at 1.

[6] G. R. Rigby *et al*., "Progress in research and management of ships' ballast water to minimise transfer of toxic dinoflagellates" in P. Lassus *et al*., eds., *Harmful Marine Algal Blooms*, *Proceedings of the 6th International Conference on Toxic Marine Phytoplankton* (Nantes: Londres, 1993) at 821-2.

[7] Martin, *supra* note 2 at 10 ("Indications in recent years indicate a major expansion in red tides"); See also A. Sournia, "Red tide and toxic marine phytoplankton of the world ocean: an inquiry into biodiversity" in Lassus *et al*., eds., *supra* note 6 at 104.

[8] Sournia, *supra* note 7 at 104.

[9] Martin, *supra* note 2 at 4.

cultural runoff, aquaculture wastes, human sewage and urban runoff. Pollution may be subdivided into two categories: "point source", where the pollution can be traced to isolated sources, for exampled, from individual ships, aquaculture farms, or land-based sources such as farms); and "non-point source", such as local congregations of farms or urban sources, from which contaminants percolate through broad areas of soil, before running off into surface or ground waters. Each of these will be examined in turn. Of the two, non-point source water pollution, which is more diffuse, is far more difficult to trace and therefore difficult to regulate.

III. Potential Sources of Water Pollution

1. Non-Point (and Point) Source Agricultural Pollution

In Canada, modern agriculture is a highly competitive, heavily mechanized, chemically intensive industrial pursuit, dominated by extremely large, specialized corporate farms.[10] Such large-scale production creates diseconomies of scale in waste disposal. The amounts of animal waste and farm pollution produced are massive. In the United States alone, animal feedlots produce 1.37 billion tons of manure annually.[11] For coastal regions, industrial agriculture is a source of excessive nutrient enrichment. Inputs of concern include runoff from artificial fertilizers and animal manures which, like human sewage, are high in nitrogen and phosphorus. Another source of pollution can be dust or run-off topsoil from ploughed fields left un-mulched and inadequately vegetated.

One major result of such excess nutrient loading in coastal waters, especially for phosphorus, is eutrophication, whereby excess nutrients spur the growth of algae such as red tide species.[12] Significantly, with

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[10] S.J. Pratt, L. Frarey & A. Carr, "A comparison of US and UK law regarding pollution from agricultural run-off" (1997) 45 Drake L. Rev. 159 at 161 (In 1790, 95% of the U.S. population farmed; in 1993, only 1.9% did).

[11] M.L. Nardo, "Feedlots—rural America's sewer" (2000) 6 Animal Law 83 at 88 (estimated animal manure production in the U.S. alone was 1.37 billion tons/year, 130 times the annual quantity of sewage humans produce in that country).

[12] N. Grant, M. Moodie & C. Weedon, *Sewage Solutions: Answering Nature's Call* (Powys, Wales: Centre for Alternative Technology, 2000) at 81.

respect to manure-based farm wastes and sewage, it has recently been found that not only may red tide species be encouraged by the elevated nutrient levels present in agricultural runoff, but certain red tide species respond strongly and preferentially to the chemical urea, a major component of both human sewage and animal manures, as a nitrogen source, a fact which might allow human sewage and farm waste to trigger or sustain red tide blooms.[13]

2. Point Source Pollution from Aquaculture

Finfish aquaculture farms in coastal waters are reputedly significant point sources of water pollution. Red tides also seem closely associated with aquaculture operations, though it is unclear whether the more closely monitored aquaculture farm regions simply *detect* a greater percentage of existing red tides or whether aquaculture plays a role in *initiating* or *sustaining* red tides.[14] Still in its infancy in the developed world, aquaculture is the fastest-growing area of agriculture and is being actively encouraged by the governments of various States, including Canada.[15] As such, finfish and other types of aquaculture have great potential to expand in Canadian waters, including the waters of PEI.

Finfish aquaculture can pollute water in a number of ways. Fish feeds made from fish meal normally contain thirty to eighty percent more phosphorus than fish can absorb. Plant protein-based feeds are lower in phosphorus, but are more costly and less easily available.[16] Given the ten percent annual growth rate of the aquaculture industry,[17]

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[13] R.M. Kudela & W.P. Cochlan, "Nitrogen and carbon uptake kinetics and the influence of irradiance for a red tide bloom off southern California" (2000) 21 Aquatic Microbial Ecology 31, cited to University of California at Santa Cruz, News Release, "Sewage in urban runoff may spur growth of harmful algal blooms," online: <http:www.ucsc.edu/news_events/press_releases/archive/99-00/02-00/ algal_blooms.htm>.

[14] T. Smayda & T. Wyatt, "Round Table-global spreading hypothesis" in Lassus *et al.*, eds., *supra* note 6 at 862.

[15] "The Financial and Economic impacts of Federal Regulation on the Aquaculture Industry of Canada's West and East Coasts: A phase II report of the Federal Aquaculture Regulatory Review," online: Canadian Aquaculture Industry Alliance <www.aquaculture.ca/documents/Bit%20Entire.pdf>.

[16] M.L. Brenninkmeyer, "The ones that got away: regulating escaped fish and other pollutants from salmon fish farms" (1999) 75 B.C. Envtl. Aff. L. Rev. 80 at 87.

[17] FAO, "The State of World Fisheries & Aquaculture 2000, Part 1. Review of fisheries and aquaculture," online at: <www.fao.org/docrep/003/x8002e/x8002e04.htm> at 1.

this feeding practice promises severe environmental and supply problems in the foreseeable future.[18] Finfish raised in ocean net pens contribute phosphorus-rich sediments in feces, promoting algal proliferation, and triggering or exacerbating red tide microalgal blooms.[19]

IV. Case Study: PEI, Water Pollution, And Red Tide

Canada's smallest province, PEI, sits at the confluence of various point and non-point pollution sources and relevant geographic factors. Yet, as of 1987, PEI had never experienced seafood poisonings and was believed to be a "toxin-free area." As such, it was rarely sampled for the known red tide toxins.[20] Thus, the discovery of a new and unknown toxin from an organism previously believed harmless came as a wake-up call to the industry.[21]

PEI lies at the mouth of the St Lawrence River, the major sea route to eastern Canada's larger urban centres and to the Great Lakes region. PEI's shores, especially on the northern side, are thus a natural recipient of waters containing the upstream effluent and runoff of Canada's more populous, industrialized and agriculturally intensive inner provinces. Significantly, whether due to salinity changes or nutrient inputs, freshwater runoff from upstream areas has been noted to have an impact in triggering red tide blooms within the lower Estuary and Gulf of St Lawrence. PEI's physical features are also relevant to its water pollution problem. Its sandy soils erode easily, carrying agricultural runoff from PEI's expanding, intensive, industrialized agriculture. In leaving soil bare or under-vegetated for part of the year, intensive potato cropping is highly soil-eroding. Defying provincial requirements, a large fraction of the land, 37.5 to 45.5%, is planted in potatoes more than once every third year.[22] While some farmers attempt better management practices,

[18] S. Balfry, "Interactions between dietary lipids and fish health" (Lecture presented at Aquanet II Conference, September 2002) [unpublished].

[19] Brenninkmeyer, *supra* note 16 at 80.

[20] Couture *et al.*, *supra* note 1 at 1.

[21] D.J.A. Richard, E.J. Arsenault & S.B. Eddy, "Shellfish toxin monitoring in the Maritimes: Ten years since the establishment of the Enhanced Molluscan Monitoring Program" in Lassus *et al.*, eds., *supra* note 6 at 31.

[22] *K.R.* DeHaan "Soil conservation in PEI potato land" (2002) 2408 Canadian Technical Report of Fisheries and Aquatic Sciences at 20; M. Tutton, "PEI's Red Zone: Farmers Quietly Resist New Land-Use Law" *The [Halifax] Sunday Herald* (22 June 2003), A7.

only ten percent of the land area uses a recommended, less erosive management system, called "residue management," that aims to leave as much plant material on the field as possible.[23] Complicating matters, at 24.4 people per square kilometre, PEI's approximately 140,000 permanent residents boast the densest human population of any Canadian province, producing year-round human sewage and other urban runoff. In addition to its permanent residents, the island attracts a large seasonal tourist population.

Existing records show that phosphorus and freshwater nitrogen inputs to PEI's waters have risen measurably over the last two to three decades.[24] Unsurprisingly, many PEI bays and estuaries have commonly been observed to be eutrophicated.[25] Disturbingly, neither the mats' presence nor the severe eutrophic condition of PEI's estuaries has ever been systematically monitored. According to residents, there were no algal mats as little as two to three decades ago.[26] Similar effects are observed in PEI's rivers as well.[27] Such nutrient overloads also nourish the microalgae and bacteria that trigger red tides. Overall, researchers have stated that it is unsurprising that so many PEI estuaries are eutrophicated; they predict that, given that agricultural inputs show no signs of levelling off, it is likely that PEI's estuaries will continue to experience eutrophic events more widely and frequently in the future.[28]

PEI's capture fisheries and aquaculture industry must contend with this altered environment. As noted earlier, finfish aquaculture can be highly polluting. Thus, if finfish aquaculture expands in PEI, it may add significantly to coastal water pollution problems that may initiate or sustain red tides.

Overall, PEI's polluted aquatic environment suggests an ominous prognosis. Many of PEI's industries, including agriculture, fisheries and tourism in addition to its human and wildlife residents, are highly dependent on the quality and health of PEI's waters. Unless circumstances change, PEI's coastal waters — warm, sheltered, over-nourished, eco-

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[23] DeHann, *ibid*. at 20.

[24] Richard, Arsenault & Eddy, *supra* note 21 at 144.

[25] Richard, Arsenault & Eddy, *supra* note 21 at 142.

[26] Richard, Arsenault & Eddy, *supra* note 21 at 143.

[27] "What's killing Mill River?" *The PEI EcoNet News* (Feb 23, 2003), online: PEI EcoNet <www.isn.net/~network/enews.html>.

[28] Richard, Arsenault & Eddy, *supra* note 21 at 145.

logically imbalanced, and pathogen-filled — seem to offer an ideal spawning ground in which red tide species may be nurtured, initiating novel, toxic red tides with increasing frequency in the foreseeable future. This will demand increased vigilance and caution, and exact an ever higher toll on local industries, residents, and natural ecosystems into the future.

V. The Legal Framework Addressing the Red Tide Problem

1. International Law

Since the 1970s, pollution of the marine environment has been recognized as an urgent global problem in a number of legally binding global treaties and non-binding, "soft law" commitments. While Canada did not ratify the legally binding *United Nations Convention on the Law of the Sea* (UNCLOS),[29] much of UNCLOS has been absorbed into binding customary international law to which Canada and other countries are generally subject, absent express domestic legislation to the contrary. In the Preamble, UNCLOS emphasizes "integration", noting that, "[T]he problems of ocean space are closely interrelated and need to be considered as a whole."[30] With respect to marine pollution, in Part XII of UNCLOS, Article 192 notes that states have an "obligation to protect and preserve the marine environment," while Article 194 obliges signatory states to take "best practicable" measures for the prevention of marine pollution by any source (as per Article 194(3)(a)): "the release of toxic, harmful or noxious substances…*from land-based sources*" [emphasis added]. This would cover land-based agricultural pollution of rivers draining into coastal waters, creating the conditions necessary for red tide.

Under UNCLOS, not only is there a legally binding obligation to protect *domestic* marine waters from pollution, but also an obligation to protect foreign waters. Article 194(2) imposes a duty on states to

[29] United Nations Convention on the Law of the Sea, Dec. 10, 1982, art. 57, 1833 U.N.T.S. 397, 419.

[30] *Ibid.*

take measures "to *ensure*" [emphasis added] that domestic pollution problems, for example, nutrient pollution and red tide, are not exported to other states, suggesting a strong obligation to deal proactively with coastal red tides and water pollution. In terms of domestic application, Article 207(1) requires states to adopt national laws and regulations aimed at preventing, reducing, and controlling "pollution of the marine environment by land-based sources, including rivers, estuaries, pipelines and outfall structures." Article 213 requires states to *enforce* their domestic laws created to minimize land-based marine pollution. Finally, Article 207(4) requires that states cooperate regionally and globally in pursuit of marine protection.

The global recognition of the seriousness and need to address the problem of land-based pollution of the marine environment continued in subsequent global agreements. In the non-binding Rio Declaration,[31] the need for a more proactive and anticipatory approach to environmental protection was noted, along with the endorsement of the precautionary principle or approach.[32] While no binding global 'Convention for Protection of the Marine Environment from Land-Based Activities' exists, in 1995, 108 nations, including Canada, adopted the soft law Washington Declaration and Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), which expressly recognizes the urgent need for marine pollution prevention.[33] The GPA notes that eighty percent of oceanic pollution originates on land via municipal sewage, industrial effluent, agriculture and sediment runoff,[34] accumulating in the near-shore areas and affecting many of the most productive coastal environments where seventy-five percent of the world's population lives.

Once again, in the GPA, integration is central: "The state and health of the oceans are closely related to ecosystem and public health concerns

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[31] "Rio Declaration" (1992) 31 International Legal Materials 874.

[32] D.L.VanderZwaag, P.G. Wells & J. Karau, "The Global Programme of Action for Protection of the Marine Environment from Land-Based Activities: A myriad of sounds, will the world listen?" (1998) 13 Ocean Yearbook 185.

[33] "The Washington Declaration on Protection of the Marine Environment from Land-Based Activities", online: UNEP <www.unep.org/unep/gpa/pol2b12.htm> [Washington Declaration].

[34] "Why have a GPA?" online: Global Program of Action for the Protection of the Marine Environment from Land-Based Activities <http://www.gpa.unep.org/about/default.htm#tag1>.

and food security issues."[35] In particular, of its nine target categories, the GPA assigns a very high priority to untreated wastewater, especially human sewage, which it notes is the source of inputs of pathogens, sediments, and de-oxygenating nutrients to the aquatic and marine environment. It acknowledges these as causing serious problems of human and ecosystem health, valued at ten billion dollars in damage each year.[36] Yet, as some studies confirm, "agricultural runoff contributes as much *if not more* [nutrients and bacteria] than human sewage inputs"[37] [emphasis added]. Curiously, despite the similarity of animal manure and sewage, and the much greater volumes of the former, agricultural manure waste is *not* a high priority for action in the GPA. Rather, two general and rather nebulous categories of "nutrients" and "sediments" are listed, neither of which is assigned as high a priority as human sewage.[38]

One reason for this distinction may be the host-specificity of some human pathogens in human sewage, as opposed to animal manure. Yet, as Canada's Walkerton disaster illustrates, animal pathogens can be equally or more harmful to humans. In any case, this explanation only addresses the microbial pollution aspect, and does not account for the failure to assign high priority to the much greater volume of nutrient and sediment pollution. In view of the relative volumes, the GPA's failure to expressly mention agricultural pollution as a specific category, while focussing priority on human sewage, seems inconsistent with its stated goals, and perhaps reflects a deliberate decision to turn a blind eye to agricultural practices in order to protect food production. Continuing this divergent trend, the United Nations Environment Program (UNEP) has recently requested convening a global conference on sewage as a major land-based pollution source, while agricultural waste receives no such attention.[39]

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[35] "GPA Strategic Action Plan to address municipal wastewater as a major land-based pollutant affecting coastal zones and marine ecosystems," online: Global Program of Action for the Protection of the Marine Environment from Land-Based Activities <www.gpa.unep.org/documents/ other/saplan/strategic20% Action%20Plan%20to%20address%20Municipal%20wastewater.pdf> at 1 [Municipal Wastewater].

[36] Mansi Jasuja "Water supply and sanitation coverage in UNEP Regional Seas: Is there a need for regional wastewater targets?" (The Hague: UNEP, 2002) at 33.

[37] Nardo, *supra* note 11 at 93.

[38] Washington Declaration, *supra* note 33 at 2.

[39] Municipal Wastewater, *supra* note 35 at 1.

Despite these flaws, the GPA offers a framework for addressing marine pollution for implementation by adopting states. As noted, like UNCLOS, the GPA emphasizes integration. For example, it encourages the integration of water supplies and wastewater treatment and the integration of the concepts of public and ecosystem health.[40] Another key principle recognized in the GPA is prevention of pollution at the source wherever possible. Canada's program for implementation of the GPA, the National Program of Action for the Protection of the Marine Environment from Land-Based Activities (NPA), published in June 2000, echoes the GPA and builds on the aforementioned principles of pollution prevention and integrated management.[41] The NPA focuses on the same nine categories of inputs, again including "human sewage" and the general categories of "nutrients" and "sediments," but never expressly mentioning agricultural waste. As in the GPA, the lack of an express category for agricultural waste seems to reflect a general lower priority given to agricultural waste as a specific target while assigning sewage a high priority. As noted, the inconsistency may reflect entrenched historical views that agricultural activities are environmentally benign, that food security is a more urgent concern than, and somehow separable from, environmental security, and that there presently exist few or no practical alternatives to current, polluting agricultural methods.

The urgent need for an environmental baseline from which to establish progress in achieving water quality objectives prompted the Global International Waters Assessment (GIWA) in 1997. UNEP Executive Director Klaus Toepfer has stated: "The lack of an International Waters Assessment has been a unique and serious impediment to the implementation of on-the-ground action [in the protection of water quality]."[42] To address this deficit and thus presumably complement the GPA's efforts, the four-year, UNEP-led GIWA initiative, initiated in April 1999, will assess the status of the world's fresh and salt waters, and aims to identify, report on and make guidelines addressing the "societal root-causes of

[40] Municipal Wastewater, *supra* note 35 at 1.

[41] Environment Canada, "National Program of Action for the Protection of the Marine Environment from Land-Based Activities" online: Government of Canada <www.npa-pan.ca/docs/final_eng.pdf >

[42] "The Global International Waters Assessment, GIWA In Depth", online: Global International Waters Assesment <http://www.giwa.net/giwafact/giwa_in_depth_why.phtml>.

water-related problems." When completed in 2004, it should serve as an important adjunct to the GPA for the global community.

2. The Statutory Framework

In Canada, a complex patchwork of federal and provincial statutes, regulations, and policies exist that regulate issues of water quality, water pollution, nutrient overloading and their associated effects. Further complicating the picture is the constitutional structure of Canadian law, or 'Division of Powers,' which assigns power to legislate over certain categories of subjects to either the federal or provincial governments. Thus, for example, inland and coastal navigation, fisheries (except aquaculture which, through a system of Memoranda of Understanding, are managed provincially), and criminal law lie solely under federal legislative power, while authority to legislate with respect to property and civil rights within a province, or local works solely for the benefit of that province, falls to provincial legislatures to govern.[43] The lack of an express assignment of power to legislate with respect to Canada's natural environment poses problems for environmental protection; protection schemes may as a result be split geographically and must be inserted awkwardly into the federal "peace, order and good government" power as either a matter of "national concern" or as a more temporary "national emergency." This complex interaction of Canadian statutory, constitutional and interpretive case law has far-reaching implications for addressing the problems of provincial farm waste, coastal pollution, and red tide.

Canada currently has various statutes that deal directly or indirectly with the problem of land-based marine pollution. Hailed as a significant advance in marine environmental protection for its incorporation of the high environmental standard of the precautionary approach, the *Oceans Act* is such a federal statute which governs the coastal zone.[44] In its Preamble, the Act also emphasizes the importance of the "ecosystem approach" and "integrated management" of oceans and resources. Under the Act, the Minister of Fisheries and Oceans (MFO) is to encourage a

[43] *Constitution Act,1867* (U.K.), 30 & 31 Vict., c. 3, reprinted in R.S.C. 1985, App. II, No. 5 (ss. 91(10), (11) and (27) are under federal jurisdiction, while ss. 92(10) and (13) are provincial).
[44] *Oceans Act*, S.C. 1996, c.31 [*Oceans Act*].

"national strategy" for the integrated management of estuarine, coastal, and marine systems which, according to the NPA, will recognize the importance of land activities on ocean problems.[45] The language suggests a holistic watershed, or ecosystem-based, approach to coastal management in which essential elements such as rivers and other surface and ground waters must be taken into account. This optimism is supported by section 30, in Part II of the Act (the Oceans Management Strategy), which states that the national strategy will be based on principles of integrated management of "estuaries, marine and coastal waters."

However, section 28 of the Act somewhat dashes these hopes of a true ecosystem approach by expressly noting that the strategy does not apply to rivers or lakes. The reason for this exclusion stems from the constitutional requirement that these bodies of water be managed under provincial statutes as matters pertaining to "property and civil rights in the province," thus making the Act inapplicable to these nonetheless contiguous bodies of water. Because rivers, estuaries, and coasts are continuous, the exclusion of rivers from the national management strategy somewhat undermines the *Oceans Act*'s attempts to apply a true, effective integrated and ecosystem-based approach. The Act's ability to address the problem of river-borne agricultural waste polluting coastal waters, where it may cause red tides, is therefore rather limited. The constitutional exclusion of inland waters also introduces ambiguity by applying a vague semantic distinction between "rivers," which are *not* covered, and "estuaries" (river mouths draining into the sea), which *are* included in the federal strategy. No definition of "estuary" is given, nor is guidance offered as to how far inland an estuary could potentially extend federal jurisdiction upstream under the Act. The vagueness regarding how far inland an estuary extends may therefore be helpful in that it may allow the national strategy to be stretched to encompass at least some river-borne estuarine pollution.

Generally speaking, provincial jurisdiction extends to 'internal waters' landward of the low tide mark of an area of provincial land.[46] However, in an estuary this demarcation line may be unclear. Constitutional wrangling over how far inland in an estuary federal jurisdiction may ex-

[45] Brenninkmeyer, *supra* note 16 at 80.

[46] *Oceans Act, supra* note 44 at ss. 5, 9.

tend was addressed in the 1988 case of *R.* v. *Crown Zellerbach*.[47] There the Supreme Court of Canada ruled that, because of the indivisibility of marine pollution and its importance to the nation's environment and the fact that a single province would be unable to solve the problem, permitless dumping into provincial estuarine *marine* waters fell under federal power as a matter of national concern. However, the court expressly left open whether federal legislation validly applied to some provincial estuarine *freshwater.* By not defining the distinction between fresh and marine estuarine waters; which present a continuum between salty and fresh in an estuary; it remains unclear how far inland the federal power could potentially extend. Absent future case law clarifying the demarcation between provincial and federal jurisdiction, the federal *Oceans Act* seems to apply to water pollution in at least some estuarine waters. In regions with low elevation or high tidal ranges, this might possibly extend the Act's application for some distance inland. Such pollution would be dealt with by regulations made by the Governor in Council, on approval of the MFO, pursuant to section 52.1 of the Act, prescribing "marine environmental quality standards and requirements." The maximum penalty for an infraction of these standards would be $100,000 per day for a summary offence and $500,000 per day for an indictable offence.

Although in Canada the 'public trust doctrine' has not been met with success, its long history and its popularity in the United States suggests that this trend may one day change. The public trust doctrine holds that certain natural resources and ecosystems (e.g., California's giant redwood forests) are of such unique and irreplaceable value that they essentially belong to the entire public of a nation, and in effect are a kind of domestic "Common Heritage of Mankind." The subjects vest as a trust in the state, derived from common law, statutory or constitutional sources, to be managed in perpetuity for future generations in the spirit of a fiduciary responsibility under a very high standard of protection, rather than liquidated as raw materials for the financial benefit of a few. Aspects of the language of the *Oceans Act* suggest the creation of a statutory public trust in Canada's oceans and marine resources. Suggestive portions include a section of the Preamble which states that Canada's

[47] *R. v. Crown Zellerbach*, 25 B.C.L.R. (2d) 145, [1988] 1 S.C.R. 401, 84 N.R. 1, 3 C.E.L.R. (N.S.) 1, [1988] 3 W.W.R. 385, 40 C.C.C. (3d) 289, 49 D.L.R. (4th) 161.

three oceans are "the common heritage of all Canadians," which implies that they are to be preserved indefinitely for all future generations. In addition, the use of the words "sustainable development" of oceans and resources (expressly defined in section 30(a) in terms of intergenerational equity to future descendents) may also imply existence of a public trust. Potentially, the existence of such a trust might offer a future cause of action against the MFO for contributing to the establishment or maintenance of red tide events stemming from a failure to prevent river-borne coastal zone pollution through an ineffective national strategy.

Another federal statute, the *Canada Water Act*,[48] appears to recognize the magnitude of the threat of water pollution, expressly noting in its Preamble that the serious national problem of water pollution is "a rapidly increasing threat" and "a matter of urgent national concern." The Act's stated aims are to optimize present and future Canadians' access to and benefit of water resources which, according to its definitions, appear to include not only freshwaters but also marine waters as well. This would seem to bode well for the Act as a tool to address coastal and river pollution by land-based agricultural or marine aquaculture waste. However, in the very complex and precise definition of the waste to be regulated under the Act, it clearly endorses the ancient, cross-cultural tradition of waste disposal in water: the Act punishes water pollution, *unless it is by certain wastes*. In addition, by defining waste only in terms of its potential detrimental effect on humans or on organisms of *human utility* rather than in terms of *environmental* damage, the Act excludes responsibility for damage to the large proportion of any natural ecosystem which is not currently known to be useful to humans — a very broad exclusion. Given the increasing integration of the fields of public and ecosystem health noted by the GPA and illustrated by the emerging scientific literature on red tides, this narrow definition of waste seems short-sighted.

In addition, it appears that the Act does not even protect all waters under its scope: under section 11 of the Act the Minister, (on approval of the Governor in Council, may designate only certain waters as "water quality management areas" to be governed by a corporate agency. Section 9's prohibition on polluting such water quality management areas or places draining into them seems sensible enough, but as noted above

[48] *Canada Water Act* R.S. 1985, c. C-11

this protection is removed for pollutants "in quantities and under conditions prescribed for waste disposal." Thus, perhaps the point source effluent from an overflowing manure lagoon or aquaculture cage, or the non-point source runoff from over-fertilized pastures, may be wastes prescribed for disposal and escape sanctions under the Act.

However, if pollution becomes excessive and the waters of "any interjurisdictional area" become a "matter of urgent national concern," under section 13, Cabinet, on approval of the Minister, may designate that body of water as a water quality management area, whose agency may make and implement section 15 plans and programs aimed to "restore, enhance and preserve" its water quality. While this approach is more reactionary than the precautionary approach one might expect for protecting such an urgent national concern, it does have some promise. The term "interjurisdictional" is defined as encompassing any waters, whether international, boundary or other, situated entirely within a province or not, which significantly affect the quantity or quality of waters outside the province. By this definition, PEI's interjurisdictional coastal waters, including the adjacent St Lawrence — which are shared with the adjacent provinces of Nova Scotia, New Brunswick, and Quebec, and the French islands of St Pierre and Miquelon — could be potential candidates for declaration as water quality management areas since all may affect waters outside the province of PEI by causing severe river and coastal pollution, turbidity, eutrophication, and possibly red tides.

Yet, this declaration depends on the limiting step of the will of Cabinet and the Minister and is thus far from automatic. Under section 18, the Governor in Council may make regulations stipulating the specific substances and concentrations thereof permissible in these managed waters, on pain of fines of up to $5,000 per day (section 30(1)). Given the great difficulty of tracing non-point source land-based nutrient pollution to a single culprit, such fines may mostly attach to point source agricultural pollution, such as short-term lagoon overflows, spills, or storm damage. Because of their brevity, these nonetheless severe infractions might only generate small fines for a large corporate farm or other industrial polluter. These would not serve as a strong deterrent against future violations. Overall, the Act does not adequately address the problems of non-point source coastal water pollution.

Another federal act, the *Navigable Waters Protection Act*,[49] aims to protect waters used for navigation, thus encompassing some coastal waters. Section 22 prohibits persons from depositing, or allowing to be deposited material, including earth, rubbish, or "other material," liable to sink to the bottom of *any water, any part of which is navigable*, or that *flows into* any navigable water less than twenty fathoms deep. Section 21 has a similar prohibition on sawdust and similar wood-based deposits that can be *a component of* farm waste. The prohibitions set out in sections 21 and 22 seem competent to deal with a negligent farmer who allows runoff materials to flow into coastal waters, coastal waters less than twenty fathoms deep, large navigable rivers, or even into the smallest stream that feeds into navigable rivers. This federal act also applies to provincial rivers because of the federal assignment of power over navigation generally. However, the main purpose of the clauses appears to be to guard against obstruction of transport, so charges under this Act would mostly address physical obstructions such as siltation by agricultural topsoil runoff from farms, though it is possible that excessive macroalgal growth from nutrient pollution, which can in turn lead to increased sedimentation that can hamper transport, may be caught as well.[50] Once again, the maximum penalty for violating section 22 is only $5,000 per day, a relatively small incentive to farmers to mulch, use cover crops or residue management to reduce the amount of erosion into PEI's rivers and coast. In addition, under section 23, Cabinet can even exempt certain rivers or waters from this scant protection and, similarly, the Minister of Transport may also designate particular coastal waters where depositing such material in less than twenty fathoms of water is permissible (section 24).

At first blush, the precautionary *Canadian Environmental Protection Act, 1999* (CEPA)[51] might seem well-suited to address coastal pollution: the Act features two parts (Parts 4 and 7) relevant to aquatic pollution. In Part 4, "Pollution Prevention," the Minister of the Environment may assess whether a "substance" is toxic or capable of becoming so (section 71.1), and if so, she may list it in Schedule I. Unfortunately, past defi-

[49] R.S. 1985 c. N-22.

[50] J.C. Kluge, "Farming by the Foot: How Site-Specific Agriculture can Reduce Non-Point Source Water Pollution" (1998) 23 Colum. J. Envtl. L. 89 at 104.

[51] S.C. 1999, c. 33.

ciencies in the requisite Ministerial will are evidenced by a list which is woefully short; a mere fifty-six of some 20,000 suspected toxic substances are listed in Schedule I. Notably, Schedule I does not list any of the substances implicated in coastal pollution and red tide initiation, such as farm waste, aquaculture effluent, urea, topsoil, or silt as toxic substances, so none of these would be covered or regulated under Part 4.

In Part 7, "Controlling Pollution and Managing Wastes," the possibilities seem broader: three divisions appear relevant. In Division I, 'Nutrients," section 118 permits Cabinet to make regulations regarding the presence and amounts of nutrients to prevent or reduce growth of aquatic algae that might interfere with ecosystem functioning or "degrade or alter a process to be detrimental to use by humans, animals, or plants." Such regulations could provide strong protection against exactly the types of nutrient runoff or aquaculture waste that promote red tide formation, such as urea, phosphorus, or perhaps artificial fertilizers; but, as before, the creation of such regulations depends on the vagaries of political will and may thus be a long time in the making, if they appear at all.

Optimistically, the rather brief Division II, "Protection of the Marine Environment from Land-Based Sources of Pollution" (its title apparently reflecting the GPA's influence), defines land-based pollution as including both point and non-point sources (section 120), and expressly includes land-based effluents delivered via a pipe-line, such as a sewage outflow pipe or stormwater culvert, which might therefore cover river-borne farm wastes. Section 121 also authorizes the Minister, after consulting with other ministers, to issue "environmental objectives, guidelines or codes of practice" based on UNCLOS' recommendations to prevent or reduce such marine pollution. While supportive, such issuances would be merely voluntary rather than enforceable regulations and their issuance would be predicated on the existence of the required degree of Ministerial will.

The title of Division III, "Disposal at Sea," seems to suggest that it refers only to dumping from vessels, but in fact it also extends to disposal via "another structure" (section 122) which may be defined by Cabinet (section 135). Theoretically, this might include an aquaculture cage from which waste feed or fecal materials are flushed into the sea, or a land-based effluent pipe or stormwater culvert emptying polluted runoff into the sea. However, reflecting the ancient tradition of using

the sea and other bodies of water as repositories for waste, the section exempts the "normal operations" of that vessel or other structure, if "operated for the purpose of disposing" of such substances at sea. Thus effluent pipes and stormwater culverts would be exempt, although perhaps aquaculture cages might not be. Division III reveals a clear bias, viewing wastes as less harmful to ocean waters than other substances. For example, section 125 (1) prohibits any person from disposing of a substance in a wide range of sea areas, unless the substance is a waste (as defined in Schedules 5 and 6), and the disposer holds a permit issued under sections 127-8. Reassuringly, under section 129, the permit may contain conditions for the protection of marine life, human life or ocean usage. However, less reassuring is the fact that the Minister, in section 128, is *bound to* issue the permit if disposal is "necessary to avert health or environmental emergency," where there is no other feasible alternative, for example perhaps where wastes have accumulated to the point of being a threat to public health. Under section 135, Cabinet regulations can limit the quantity of wastes disposed (e.g., from an aquaculture cage's sediments), but considering technical difficulties and the shortage of alternative disposal sites this seems unlikely.

Finally, the federal *Fisheries Act*[52] offers two relatively strong avenues to indirectly protect the aquatic environment via the federal government's responsibility over fisheries: sections 35(1) and 36(3). This Act protects both inland and coastal fisheries, with the exception of aquaculture, which by a Memorandum of Understanding (MOU) is governed by each province. Under a separate Memorandum of Understanding, the Department of Fisheries and Oceans (DFO) and Environment Canada (EC) jointly enforce the *Fisheries Act*.[53] The EC enforces section 36(3), which prohibits "deleterious deposits" into waters frequented by fish, including shellfish, or in areas where the substance may enter such waters. The contours of the prohibition have been outlined in a number of important cases, such as *R.* v. *McMillan-Bloedel (Alberni) Ltd*.[54] In that case, it was determined that it is the *substance before* rather than *after entering the water* that must be deleterious, or alternatively, according to

[52] R.S. 1985 c. F-14.

[53] D. Aggett, L. Murphy & D.G. MacDougall, "Acts, regulations and policies pertaining to protection of habitats on PEI" (2002) 2408 Canadian Technical Report of Fisheries and Aquatic Sciences at 14.

[54] *R. v. MacMillan-Bloedel (Alberni)* Ltd. (1979), 47 C.C.C. (2d) 118n (S.C.C.).

the definition, it could also be that the substance *makes fish deleterious to human use*. The court defined "frequented by fish" as water which at some time has fish in it. Illustrating the deleterious effect of manure on fish, in 1995 in the United States millions of gallons of spilled manure killed ten million fish.[55] Therefore, section 36(3) could be triggered if farm waste (pathogenic, nutrient-rich and oxygen-absorbing and proven to be deleterious to fish) is deposited in rivers containing fish, or alternatively, leads to fish or shellfish later becoming infected with red tide, thereby rendering them toxic and deleterious to human use.

To make out a defence to section 36(3), the polluter must show that they exercised due diligence, elements of which were detailed in the case *R.* v. *Bata Industries*:[56] existence of a pollution prevention 'system'; conforming with industry practice; regular supervision, inspection and reporting; and review and substantiation by superiors, who respond promptly to address environmental concerns brought to their attention by concerned parties.[57] Under this scheme, a manure lagoon inspected and repaired periodically but overflowing in a heavy rainstorm might, unless negligently constructed, conform to industry practices and satisfy the due diligence requirement. Similarly, industry practices of applying only pre-set amounts of fertilizer to a field, or fish-feed to an aquaculture cage might also succeed in showing due diligence.

The DFO enforces section 35 of the Act, which governs the "harmful alteration, disruption or destruction" (HADD) of fish habitat. "Harmful alteration" is defined as a change that indefinitely reduces at least one fish life process, but does not destroy the habitat outright; "disruption" is a temporary change that reduces one or more fish life processes, while "destruction" permanently eliminates the possibility of a fish life process. HADDs may include the siltation of rivers and coastal zones by runoff farm topsoil, obscuring spawning areas, and might also encompass the runoff of soluble nutrients, leading to algal overgrowth, fish-killing anoxic events or toxic red tides. Works leading to a HADD are prohibited unless authorized by a permit. Notably, the DFO's 1986 "Policy for the Management of Fish Habitats,"[58] which covers marine, freshwater and

[55] Nardo, *supra* note 11 at 83.

[56] *R. .v. Bata Industries* (1992), 70 CCC (3d) 394 (Ont. Prov. Ct.).

[57] *Ibid*. at para. 146ff.

[58] Fisheries and Oceans Canada, cited in Aggett, Murphy & MacDougall, *supra* note 53 at 17.

estuarine habitats, aims to maintain, rehabilitate and increase current fish habitat, with the objective of an overall net gain in available fish habitat. It seems quite likely that PEI's farming practices, which result in widespread river and coastal eutrophication, periodic anoxic events and perhaps also red tide events, could be construed as violating section 35 and negatively impacting the DFO's ability to satisfy its 'net gain' fish habitat policy in this region.

3. Provincial Statutory Law

In addition to federal statutes, a number of provincial statutes are also relevant to the issue of water pollution and red tide. Some parts of PEI's *Environmental Protection Act*[59] specifically or indirectly protect surface waters, such as rivers, from pollution. For instance, section 7.1 authorizes the Minister to issue stop orders if a contaminant poses a potential risk of environmental damage; section 9.1 requires anyone releasing a contaminant that could exert significant harm on the environment or cause public concern to obtain provincial Ministerial approval, possibly involving an environmental impact assessment. A contaminant is defined as "any substance that can adversely affect environmental or human health," which could perhaps include sewage, urea, or fertilizer. Another interesting innovation in section 11 of the Act is the requirement for buffer zones of non-crop permanent vegetation, which protect waters by absorbing excess nutrients and catching silt within their roots. These are required around crops, intensive livestock operations, and forested riparian zones. However, this requirement reduces the area of arable land an owner may cultivate, thereby cutting into profits. Unfortunately, ponds, drainage ditches, and coastline are exempt from this requirement, measurably limiting the benefits it could provide since these are some of the most important areas into which polluted water will drain. Fines for infractions include a minimum fine: amounts are $200-10,000 for an individual and $1,000-50,000 for a corporation (most farms are corporate-owned), and may include restitution and up to ninety days imprisonment. According to reports for 2002-3, for some land owners these fines or their likelihood of enforcement are insuffi-

[59] R.S.P.E.I. 1995 c. E-9

cient to compel compliance with the law: at least 2,800 hectares are in violation of section 11.[60]

Under section 5 of the provincial *Farm Practices Act,*[61] complaints might be made by citizens with respect to farm-based river or coastal pollution. However, the categories for complaint are limited by the statute, so that presumably the complaint would have to be characterized as dust, an odour, or as a form of "other farm practice" to be considered for possible redress. This offers a very limited range of possible complaints in view of the wide array of effects of agricultural pollution on surface, coastal and groundwaters. However, this range of options is even further reduced in section 2(1) by the exemption of "normal farm practices" if complying with the *PEI Environmental Protection Act* and certain other provincial Acts, for which case no injunction or relief will be granted. To further immunize themselves against such challenges, farmers can apply to have particular practices, such as manure lagoon design or maintenance, designated by a farmer-dominated board as "normal farm practices" via section 13. Thus, the Act appears to offer only limited protection from agricultural pollution, if any, revealing once again an apparent societal trend of turning a blind eye to agricultural environmental abuses.

In the Dust Bowl 1930s, crop rotation was found to be important in combating both wind erosion and water pollution by allowing fields to return to sod or to other crops that improve the soil's structure and nitrogen content and do not concentrate the same insect or weed pest species.[62] Accordingly, another provincial act of relevance is the *Agricultural Crop Rotation Act*,[63] effective April 2002, which expressly as its purpose in section 2 the maintenance and improvement of surface water and groundwater quality as well as the preservation of PEI's soils, reflecting a new provincial policy directly aimed at an aspect of PEI's agricultural water pollution problem: pollution by runoff topsoil, dust and associated nutrients. Section 7(2) of the Act stipulates that farmers are prohibited from planting "regulated crops," such as erosion-causing potatoes, on any land parcel greater than a hectare with greater frequen-

[60] Tutton, *supra* note 22.

[61] R.S.P.E.I. 1998 c. F-4.1.

[62] J.H. Davidson, "Commentary: Using Special Water Districts to Control Non-point Sources of Water Pollution" (1989) 65 Chicago-Kent L. Rev. 503 at 510.

[63] R.S.P.E.I. 2002 c. A-8.01

cy than once every three years. This is in order to allow erosion-limiting sod vegetation to get established, protecting the soil from runoff and somewhat restoring its nutrients from intensive depletion. Section 11 provides for a $1,000 per hectare fine for violation of this section. This is a relatively low fine in contrast with crop revenues.

Another protection exists in section 8, which states that land parcels over one hectare in area in any so-called "red zone" (i.e., part of the land having slope greater than nine percent) must not be planted with high-erosion crops, such as potatoes, in order to limit the amount of runoff topsoil and nutrients into adjacent waters. A similar $1,000 per hectare fine attaches to violators of this section. Unfortunately, farmers have apparently resisted complying, and inspection and enforcement has not been rigorous. Perhaps forty percent of existing potato fields are in violation of section 7, and at the start of the 2003 growing season, over 1,600 hectares were in violation of section 8.[64] Thus, the partial promise offered by this Act towards reducing the water pollution problem has not yet materialized.

Other provincial statutes offer limited options for regulating PEI's water pollution problem. For example, under the *Dairy Industry Act*,[65] regulations regarding the "sanitary conditions" of dairy farm premises may be made that might possibly allow room to regulate design and maintenance of manure storage facilities. In addition, under the provincial *Planning Act*,[66] the Minister may make regulations designating certain land areas as "conservation zones" or "environmentally sensitive." This provision has in fact been used in the past to protect a riparian forest buffer strip along the Morell River from clearcutting, a nutrient and silt-absorbing area, therefore also protecting regional waters. Similarly, PEI's *Natural Areas Protection Act*,[67] which designates land areas as protected by a restrictive covenant, would prevent clear cutting of riparian nature strips. However, the fines for infractions are so miniscule, at a maximum of $1,000 plus restitution, as to fail to deter serious or corporate violators. Yet, such buffer strips would, if more widely obligated, and not requiring designation by the Minister, be ex-

[64] Tutton, *supra* note 22.
[65] R.S.P.E.I. 1987 c. D-1.
[66] R.S.P.E.I 1988 c. P-8.
[67] R.S.P.E.I 1988 c. N-2.

tremely helpful in combating PEI's aquatic pollution problem. However, this does not treat the source of the pollution so much as alleviate the symptoms and results.

Finally, in PEI, by a Memorandum of Understanding with the federal government,[68] aquaculture falls under provincial jurisdiction and is governed by the provincial *Fisheries Act*.[69] As noted earlier, ninety-five percent of PEI's current aquaculture industry focuses on shellfish; which, being filter feeders, are generally much less pollution-producing; rather than finfish, although this situation might change in the future. There appear to be no sections of the provincial *Fisheries Act* that might guard against water pollution from aquaculture; which is perhaps due to the federal constitutional jurisdiction over water pollution as a deleterious deposit under the federal *Fisheries Act*.

Overall, at both federal and provincial levels, Canada's statutory framework for dealing with water pollution and its complex constitutional overlay, are fragmented and not adequate to effectively handle the task of controlling the problem of serious waste from agriculture, and potentially, aquaculture. It seems that in this complex patchwork, there has been a consistent trend to exempt wastes, especially wastes associated with food-growing industries, from strict regulation and scrutiny. This unfortunate and limited view, reflected at the international level in various agreements, does not seem likely to change in the near future given the lack of priority that agricultural waste, or nutrients and sediments, has been given in the GPA and NPA. It is this historically entrenched attitude to agriculture that is responsible for PEI's current water pollution problems. In the United States' Chesapeake Bay, when a connection was made linking local algal fish kills to agricultural overenrichment by poultry farmers, outcry by local fishers, scientists, and environmentalists against the economically powerful poultry industry (worth $2.1 billion to Maryland's economy) resulted in new, stricter regulations being enacted. Sadly, it has been reported that despite these new laws, local water quality has actually worsened, due to inconsistent legislative efforts by neighbouring states.[70] However, in PEI, given the

[68] "Regulation and Support for Aquaculture in Canada," online: Office of the Commissioner for Aquacuulture Development <www.ocad.gc.ca/eregulationandsupport.html>.

[69] R.S.P.E.I 1996 c. F-13.01.

[70] J.P. Almeida, "Non-Point source pollution and Chesapeake Bay Pfiesteria blooms: the chickens come home to roost" (1998) 32 Ga L. Rev. 1195 at 1206.

comparatively lesser role of the fisheries industry relative to the economically powerful agricultural industry, no such balancing of equities appears likely unless water quality problems increase to the point where tourism decreases and the essential character and identity of the region are altered.

Despite the NPA's lofty ideals of integration and pollution prevention, Canada's current approach to water pollution prevention and agricultural waste remains fragmented, less than ecosystem-based, and short-sighted, valuing agricultural production over environmental integrity. By downplaying or turning a blind eye to agricultural environmental harms, thereby undermining the very ecosystems upon which agriculture depends, this regulatory approach will ultimately fail. This disintegrated approach is evident in the NPA's assigning a high priority for human sewage as a coastal pollutant while unjustifiably ignoring the effects of similar manure-based inputs. Agricultural waste has traditionally attracted low priority as a water pollutant, a fact which has allowed agricultural waste problems to increase, even while effluent standards for other industries have improved.

4. Comparative Legislation

In the United States, the *Clean Water Act*[71] aims to regulate water pollution of all bodies of water, including fresh and salt, flowing and standing. While this approach to water pollution might appear less fragmented and more coherent a policy than Canada's patchwork of statutes, in reality it does not appear to have been much more successful. While some state that the *Clean Water Act* has been relatively successful in regulating *point* source water pollution, they also concede its widespread failure to address *non-point* source agricultural runoff.[72]Agricultural pollution problems are due to behavioural choices, which seem to present challenges for inspection or enforcement.[73] Due to enforcement and inspec-

[71] *Clean Water Act* 33 U.S.C. §§ 1251-1387.

[72] Kluge, *supra* note 50 at 90.

[73] L.C. Frarey, R. Jones & S. Pratt, "Conservation Districts as the Foundation for Watershed-Based Programs to Prevent and Abate Polluted Agricultural Runoff" (1994) 18 Hamline L. Rev. 151 at 158.

tion problems,[74] and various exemptions and laxity in the Clean Water Act's agricultural permit system,[75] the Act has failed to effectively regulate water pollution. The results have been eutrophicated hypoxic waters and some devastating red tide events plaguing waters near intensive agricultural regions or populous urban centres, such as occurred in Long Island Sound, where the estuary drains a watershed supporting 8.5 million people and requires sixty sewage treatment facilities.[76]

Some improvements have been recommended. During the Great Depression, when wind erosion converted United States' farms to a dustbowl, the U.S. Department of Agriculture began administering farms according to watershed-based "soil conservation districts."[77] These districts were organized along hydrological lines to minimize both wind and water erosion of soil and associated polluted runoff. Sadly, when conditions improved, this soil conservation policy was abandoned in favour of intensive production so that the current administrative scheme is now organized along county lines that cut across and ignore watershed boundaries.[78] Yet, because of widespread United States agricultural pollution problems, many scientists and environmentalists now call for a return to watershed-based management as a means of combating both soil erosion and agricultural water pollution generally: "Water pollution problems are fundamentally institutional problems."[79] In this proposal, each watershed district would emphasize local participation in enforcement activities, with recourse to state authorities for recalcitrant chronic polluters, thereby easing inspection and spreading the cost of waste disposal equitably over all the users of the watershed.[80] Perhaps Canada might consider doing the same.

In the United Kingdom, a different route has been taken**.** The U.K., a member of the European Community, must comply with Community Directives on water pollution, although it has discretion as to how to administer them domestically. The major focus appears to have been

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[74] Pratt, Frarey & Carr, *supra* note 10 at 176.

[75] Pratt, Frarey & Carr, *supra* note 10 at 168.

[76] A. Powers, "Reducing Nitrogen Pollution on Long Island Sound: Is There a Place for Pollutant Trading?" (1998) 23 Colum J. Envtl. L. 139 at 143-5.

[77] Frarey, Jones & Pratt, s*upra* note 73 at 153.

[78] Frarey, Jones & Pratt, s*upra* note 73 at 158.

[79] Frarey, Jones & Pratt, s*upra* note 73 at 151.

[80] Davidson, *supra* note 62 at 516.

on dealing with agricultural nitrate pollution of water, as in Council Directive 91/676,[81] despite the fact that many authors feel that phosphorus is the more important excess nutrient in causing eutrophication of water. The Directive calls for members to identify vulnerable areas where nitrate exceeds fifty milligrams per litre in adjacent waters in order to develop voluntary good agricultural practice codes and to limit manure application to 210 kilograms of nitrogen per hectare. In compliance with the Directive, the U.K. has created a scheme of nitrate sensitive areas and developed a Code of Good Practice for the Protection of Water that sets a maximum for manure application of fifty tonnes per hectare in sensitive regions where groundwater nitrate may not exceed fifty milligrams per litre.[82]

Initially, the U.K.'s nitrate sensitive areas (NSA) scheme was organized on a voluntary basis, with farmers being compensated financially for not removing hedgerows and woodland vegetation, and for either limiting fertilizer application and planting winter cover crops, or for converting some sensitive crop land to woodland or grassland, at a total cost of 8.3 million pounds Sterling. The result was that chemical fertilizer use decreased from 141 kilograms per hectare to 103 killograms per hectare, with similar results for manure. The excess manure was disposed of on other land in less sensitive areas, not a total solution. Building on this success, in 1995, the U.K. upgraded the voluntary NSA scheme to a mandatory one of "Nitrate Vulnerable Zones" (NVZs), resulting in complaints from farmers and an uncertain future for the NVZ program.[83] Perhaps the lesson for Canada, is that agricultural nutrient limitation programs can be successful when they target the appropriate nutrients, such as nitrogen and phosphorus, and when they ensure compensation to farmers for lost cropland.

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[81] EC, *Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources*.[1991] O.J. L. 375.

[82] Pratt, Frarey & Carr, *supra* note 10 at 179-81.

[83] Pratt, Frarey & Carr, *supra* note 10 at 182-187.

VI. Resolving Coastal Water Pollution Problems

The best approach to coastal pollution and red tide problems will employ both legal and extralegal reforms. Optimistically, many ecosystems are resilient within certain bounds and can recover if given the opportunity to restore a degree of ecological balance. As noted, in Japan's Seto Inland Sea, pollution controls greatly reduced the frequency of red tide events within only a few years. In other cases, improvements in water quality may take decades to be felt, as in Lake Erie where it took thirty years for the results of pollution controls to be noticeable.[84] Certainly, Canada's water pollution legislation would benefit from amendments that create a less fragmented, more whole-ecosystem or watershed-based approach. Yet, some of the problems inherent in putting in place such an approach derive from Canada's constitutional framework and, absent a constitutional amendment assigning a clear environmental head of power, environmental problems such as water pollution may continue to defy simple legal resolution. Water pollution is a complex, many-faceted problem, touching on fisheries, water supplies, transport, local industries and many other areas, which makes it complex to address in an all-encompassing constitutional manner. However, the importance of waters and the great distances over which water pollution may be carried in inter-provincial, international ground and surface waters, suggest that the matter may be best addressed as an issue of *national* concern and therefore federal jurisdiction.

Conversely though, local community-based initiatives and participation are essential to addressing the pollution problem:

> Flowing water recognizes no political boundaries, but rather operates within its natural jurisdiction — the watershed. [Therefore][n]on-point sources will be controlled not by any one landowner but by a majority of land-owners in a watershed who cooperate to implement a common plan.[85]

Regional efforts such as the Atlantic Coastal Action Program (ACAP), a network of communities and organizations mobilizing to promote sustainable development via the ecosystem approach, may represent an

[84] Frarey, Jones & Pratt, s*upra* note 73 at 170.

[85] Davidson, s*upra* note 62 at 509.

incipient return to the watershed approach.[86] In addition, voluntary local agricultural conservation clubs, which promote ecological farming practices, are taking root in PEI.[87] According to the watershed approach, significant improvements may result from the cumulative effect of many minor changes in agricultural practice. These practices include using hedgerows, windbreaks, or other vegetative buffer zones around crops, pastures, or other features likely to cause pollution, and adjacent to surface waters. Other low-pollution practices include contour farming, terracing, strip-cropping, no-till agriculture, grassed waterways, cover crops, and critical area planting for steep land.[88] Unfortunately, because fungal diseases afflict PEI potatoes, organic agriculture — which leaves more organic material in the soil and causes less erosion — may be impractical. However, it has been shown that other environmental practices are feasible and can reduce farmland erosion, in some cases while boosting productivity.[89] By employing these minor cumulative changes, the landowners within a watershed can improve the aggregate water pollution flowing from their watershed into the coastal zone, thereby spreading the costs of the improvements among all users.[90]

Other improvements have been suggested. For some, pollution is effectively an irrigation drainage problem for which the remedy involves using drainage systems[91] that convert the non-point source runoff to point source pollution, which are then dealt with on a permit basis as with other industrial effluents; although, the cost of installing the infrastructure would be high. Others advocate precision farming as the way of the future, in which instead of applying nutrients, pesticides or agrochemicals at a constant rate to whole fields, and usually over-applying

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[86] "What is the Atlantic Coastal Action Program?" online: Environment Canada atlantic-web1.ns.ec.gc.ca/community/acap/>.

[87] Government of Prince Edward Island, News Release, "Conservation clubs will provide good soil management practices" (25 October 2001), online: <www.gov.pe.ca/news/getrelease.php3?number=2308>.

[88] T. J. Centner *et al*., **"**Employing Best Management Practices to Reduce Agricultural Water Pollution: Economics, Regulatory Institutions and Policy Concerns" (1997) 45 Drake L. Rev. 125 at 132-3.

[89] DeHaan, *supra* note 22 at 20 (The methods and associated erosion (or nutrient runoff) decreases were: residue crop management—900% less erosion (and 7% higher yields); strip cropping—75% less; mulching –4,000% less; in addition, winter cover crops and spring plowing also reduce erosion).

[90] Davidson, *supra* note 62 at 516.

[91] Davidson, *supra* note 62 at 506.

them,[92] fields are sampled, mapped, and monitored to determine appropriate application rates for each area. This can result in smaller overall applications to land, and therefore less pollution (e.g., reductions of ten to thirty percent for fertilizer, thirty-five to eighty-five percent for herbicides, and twenty to thirty percent for pesticides),[93] but the expense and technological investment are great.[94] In the United States, this method is used on a mere 500,000 acres of 411 million acres in cultivation.[95]

Applying the ecosystem approach literally offers other possibilities. In polluting water with farm or other wastes, we are essentially discarding two valuable resources: "We are literally wasting our water and our nutrient resources along with it."[96] Significant improvements to PEI's water pollution problem might be made simply and at lower cost than cleanup or sewage plants, via engineered or constructed wetlands. These are not the same as buffer zones. These systems, through a deliberate combination of particular plants, structures, and microbes, are simple yet sophisticated biological communities in which specific microbes break down pollutants, while plants provide oxygenation.[97] They have been proven able to purify and convert excess nutrients into non-polluting, wildlife-attracting vegetation, releasing highly purified or much-improved waters.

These environmentally benign, low-maintenance systems seem to be exactly the type of low-cost appropriate technology envisaged by the GPA (Key Principle 4) in preventing water pollution. Used all over the world, in all types of climates and terrains, they have successfully treated polluted waters ranging from metal-containing acid mine tailings, toxic waste, potato field fertilizer effluent, municipal human sewage and animal manures. Most importantly, engineered wetlands have proven able to remove the most problematic nutrient, phosphorus, through a combination of flowering plants and phosphorus-consuming fish species.[98] Their only drawback may be that they require a certain amount

[92] Kluge, s*upra* note 50 at 126.
[93] Kluge, s*upra* note 50 at 126, 127, 129.
[94] Kluge, s*upra* note 50 at 131.
[95] Kluge, *supra* note 50 at 132.
[96] D. Hammer, "Shallow Ecology" in K. Ausubel, ed., *Restoring the Earth: Visionary solutions from the Bioneers* (Tiburon, CA: HJ Kramer, 1997) at 30.
[97] *Ibid*. at 36.
[98] *Ibid*. at 22.

of land, and thus would be unsuitable for very dense urban areas. While land use efficiency on PEI is always a consideration, currently, many acres are already taken up storing manure effluent. Engineered wetlands would use similar amounts of land and by removing nitrogen and phosphorus, could make an enormous difference to the quality of PEI's rivers and coast in preventing future red tides.

Along similar lines, in finfish aquaculture; if it becomes more widespread in PEI; many advocate using polyculture systems that, simultaneously and in the same area, cultivate marketable finfish, seaweeds, and filter-feeding shellfish.[99] Filter-feeding bivalves lower turbidity by absorbing sediment and nutrient particles that may trigger red tides: a kilogram of bivalve meat sequesters 16.8 grams of aquatic nitrogen.[100] Similar results are seen in Australian shrimp farms, where filter-feeding oysters removed forty-nine percent of suspended sediments, fifty-eight percent of bacteria, eighty percent of nitrogen, and sixty-seven percent of phosphorus.[101]

In addition to using nutrients more efficiently so as to prevent red tides, polyculture systems may aid finfish in surviving red tides: Whyte found that adjacent mussel communities aided in salmon survival during red tide caused by certain algal species.[102] A further ecosystem advantage offered by shellfish is that some are reef builders, providing a substrate for other marine life to colonize, thus increasing local biodiversity. Some note that polyculture requires more skill, and can reduce finfish production, but long-term benefits in water quality and fish habitat protection outweigh the disadvantages.[103] Other alternatives in finfish cultivation include using vaccines, rather than antibiotics, using plant-based feeds as opposed to polluting, ecologically wasteful fish-based feeds, and using monitoring devices to stop feeding when fish have finished eating.[104] To lessen the effects of red tides on cultured fish,

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[99] Brenninkmeyer, *supra* note 16 at 88.

[100] T. Landry, "The potential role of bivalve shellfish in mitigating negative impacts of land use in PEI estuaries" (2002) 2408 Canadian Technical Report of Fisheries and Aquatic Sciences at 156.

[101] *Ibid.*

[102] .J.N.C. Whyte *et al.*, "*Heterosigma carterae,* a major killer of pen-reared salmon in British Columbia" (1999) 2261 Canadian Technical Report of Fisheries and Aquatic Sciences at 3.

[103] Brenninkmeyer, *supra* note 16 at 88-9.

[104] Brenninkmeyer, *supra* note 16 at 87-8.

impermeable bags as opposed to open mesh net pens may be used,[105] or better siting of aquaculture farms, which is likely to grow increasingly difficult as fish farms grow in number.

However, if Canada is to satisfy the GPA and NPA key principles of pollution prevention and integration of public and ecosystem health, legislation and thinking must be updated to incorporate the understanding that agricultural pollution is serious and widespread, and that like untreated human sewage, manure-based, urea - or phosphorus-containing effluents have as serious, if not greater impact on human as well as environmental health. As shown by the experience of red tides in the United States, trying to regulate only point source pollution will not have curb red tides or other non-point source pollution problems. Others suggest using economic instruments as adjuncts to legislation, for example, nutrient trading schemes for nitrate or other chemicals, to encourage users to reduce polluting activities.[106]

Beyond the legislative inadequacies, more basic problems of inspection and enforcement of existing laws, such as PEI's *Agricultural Crop Rotation Act*, must be addressed. Enforcement deficiencies in agricultural pollution legislation seem to be widespread not only in Canada, but in U.S. as well.[107] Complementary systems of incentives to farmers, or other watershed users, adopting ecological practices or compensation for cropland lost to buffer zones are essential, as many farmers already face financial stress and the high cost of water pollution prevention may make it unlikely that most will voluntarily adopt pollution-fighting practices.[108] Such an incentive system may ultimately require a change in public thinking and education about farming and water quality preservation by all watershed users, illustrated by more conscious use and preservation of water, and by demand and willingness to pay more for food that is produced in environmentally friendlier ways.

Yet, even if improved anti-pollution laws, enforcement, practices and technologies were put in place tomorrow, because of the time required for ecosystems to recover, red tide events in PEI will probably continue and spread for years to come. Accordingly, monitoring and rapid responses are essential. Satellite imagery visualizing sea tem-

[105] Whyte *et al.*, *supra* note 102 at 104.

[106] Powers, *supra* note 76 at 139.

[107] Pratt, Frarey & Carr, *supra* note 10 at 168.

[108] Centner *et al.*, *supra* note 88 at 141.

peratures and reflectivity can aid in detecting or predicting red tides. In the Gulf of Mexico, robotic gliders will soon monitor the area for red tides.[109] Many authors call for the increased use of moored optical and chemical real-time sensors to monitor water quality and detect red tides, reporting them to a central database.[110] An international database for red tide events has existed since 1997: the Harmful Algae Data Base (HAE-DAT), operating through GEOHAB[111] (the Global Ecology and Oceanography of Harmful Algal Blooms), which is maintained by the International Council for Exploration of the Sea (ICES) and the International Oceanographic Commission (IOC). In addition, volunteer algal monitoring and land-based monitoring stations can also provide important monitoring and baseline data for modelling and early warning of the presence of toxicity. International conferences also assist by sharing information about red tides' global or local effects. The goal in gathering real-time data is to improve red tide forecasting, which is presently in its infancy.

VII. Conclusion

Three-quarters of the planet is covered by water, most of it ocean. Thus, aquatic pollution can be re-distributed by currents to even the most remote shores. At international law, the *UN Convention on the Law of the Sea* has recognized the essential interrelationship of oceanic processes, as has the GPA and Canada's most recent policy statements and domestic legislation. Yet practically speaking, little ecosystem-based effort has been made to regulate the pollution contributed to ocean environments by agriculture, effectively failing to integrate agriculture into the aquatic pollution equation at all, perhaps because of policy biases aimed at protecting food security. In PEI and a range of other intensive agricultural regions in Canada and abroad, the result has been highly eutrophicated

[109] "Robot gliders to watch red tides," online: Nature Science Update <http:www.nature.com/nsu/ 030120/030120-6.html>.

[110] J. Cullen, "Monitoring algal blooms with in situ optical sensors" (2002) 2400 Canadian Technical Report of Fisheries and Aquatic Sciences at 33.

[111] In the U.S., ECOHAB is the Environmental Protection Agency's national 'Ecology and Oceanography of Harmful Algal Blooms' initiative, which has regional monitoring programs such as ECOHAB-GOM for the Gulf of Maine.

marine communities that are experiencing frequent anoxic events and sometimes periodic toxic red tides.

Given present indications, it is clear that aquatic pollution and red tides will not fade away of their own accord. The apparent thirty-year parallel between increasing global red tide frequency and intensified agricultural production seems more than coincidence. With toxic red tides, some believe that humanity has waded into the crossfire of an ancient phenomenon too complex to be amenable to an easy technological quick fix. Further, even were such technological solutions to exist, they would not address, nor correct, the broader underlying issue of the output of marine pollution which, in the current climate of leniency towards agricultural waste, would simply continue to increase to a point where other environmental catastrophes or symptoms would probably appear. While marine systems are resilient following single disturbances (such as high nutrient input), absent changes to the legislation and practices of agriculture, these disturbances continue on a daily basis, steadily eroding the ecological capacity of these zones to recover.

The oceans are not limitless in their assimilative capacity as we have mistakenly believed: once their thresholds of assimilative capacity and resilient ability are overwhelmed, the limitations will remain for us and our descendant generations to deal with, much as we must now accept the demise of the North Atlantic cod stocks, or the loss of the Great Plains buffalo herds. We may currently be treating the seemingly limitless ocean in the same way the first colonial settlers thought of land, timber, fish or buffalo — present in such infinite abundance as to encourage waste — only to be faced with their obvious limits or total absence in subsequent generations. While PEI is an island of small size and limited assimilative capacity, more generally, it is clear that regardless of size, high levels of pollutant inputs simply cannot be deposited indefinitely into a finite and already compromised environment. PEI is, in essence, a microcosm of overtaxed coastlines everywhere in the developed world. It is eerie to contemplate that, if Canada's policies, laws, and ways of thinking remain unchanged, PEI's poisonous red tides may merely foreshadow the fate of the rest of our watery planet.